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Dual task training for improving balance and gait in people with stroke (Protocol)

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[Intervention Protocol]

Dual task training for improving balance and gait in people with stroke

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ABSTRACT

This is a protocol for a Cochrane Review (Intervention). The objectives are as follows:

To assess the treatment effects of dual task training regarding balance and gait for people with stroke.

BACKGROUND

Description of the condition

The World Health Organization (WHO) defines stroke as "rapidly developing clinical signs of focal (or global) disturbance of cerebral function, lasting more than 24 hours or leading to death, with no apparent cause other than that of vascular origin" (Aho 1980). There are three types of stroke defined by the pathological background: ischaemic stroke, haemorrhagic stroke and subarachnoid haemorrhage (Truelsen 2000). In 2010, approximately 17 million events of incident ischaemic or haemorrhagic stroke occurred worldwide and about six million people died from stroke (Krishnamurthi 2013). Stroke is the third most common cause of death after coronary heart disease and cancer (WHO 2011). It affects motor function and therefore many activities of daily living (ADL). About five million people were left with permanent disabilities due to stroke in 2010 (WHO 2011). Three out of four people with stroke were so adversely affected by their stroke that they were unable to perform basic ADL; mostly transfers (e.g. ability to move between chair and bed), dressing and walking (Jørgensen 1999). After inpatient rehabilitation, only about 7% of these people can climb stairs and walk the speeds and distances that are needed to walk competently and independently in the community (Balasubramanian 2014).

In Germany, three months after stroke onset approximately 25% of stroke survivors suffer from the severe impact on their daily activities (Ward 2005). About 17% of people with stroke experience moderate to severe disabilities three months after stroke onset (Schneider 2009). They also experience falling: up to 20% of people with stroke fall at least once in the acute care setting (Weerdesteyn 2008). Hence, falling is the most frequent medical complication during hospitalisation after stroke (Weerdesteyn 2008). There are physical and psychosocial consequences, such as fractures and fear of falling, that could occur from a reduction of daily activity to a loss of independence (Weerdesteyn 2008). In one prospective cohort study, Mackintosh and colleagues found out that 4 out of 10 participants reduced their activities after a fall and 5 out of 10 falls resulted in an injury (Mackintosh 2005). Therefore, effective training strategies are necessary to improve ambulation and balance to facilitate a better participation in daily life.

There are different physical rehabilitation interventions for improving ambulation and balance. States and colleagues found insufficient evidence for overground gait training to improve gait function (States 2009). Saunders and coworkers came to the conclusion that there is sufficient evidence for cardiorespiratory and mixed training within post-stroke rehabilitation programmes to improve gait speed, tolerance of walking and to some extent balance (Saunders 2016). Mehrholz and colleagues stated that electromechanical-assisted gait training in combination with physiotherapy is more effective for people with stroke regarding independent walking than just physiotherapy alone (Mehrholz 2015). In another review, Mehrholz and coworkers found no advantage of treadmill training to improve the ability to walk independently; however, walking endurance and walking speed may increase (Mehrholz 2014). English and colleagues discovered that circuit class therapy is effective for people with a moderate stroke to improve their mobility (English 2010). French and coworkers showed that repetitive task training improved walking, walking speed and sit-to-stand ability (French 2007). In contrast, Pollock and colleagues found insufficient evidence relating to their primary outcome, the ability to sit-to-stand independently (Pollock 2014a). Barclay-Goddard and coworkers found that force platform feedback improved stance symmetry, but not sway in standing, clinical balance outcomes or measures of independence for people with stroke (Barclay-Goddard 2004). Verheyden and coworkers concluded that there is currently insufficient evidence that exercises prevent falls or decrease the number of falls after stroke rehabilitation (Verheyden 2013). One review by Pollock and coworkers found that physical rehabilitation has a beneficial effect on functional recovery after stroke and that there are high-quality reviews that show the effectiveness of task-specific treatments (Pollock 2014b). In summary, there is some evidence, but research still has to identify which individual treatment components are the most beneficial. This review will clarify if dual task training is effective for improving balance and gait.

Dual task training might be a promising approach for improving gait and balance (Plummer 2014). Simultaneous training of motor or cognitive dual tasks during conventional therapy has already been considered as beneficial for different groups of patients (Fritz 2015; Pichierri 2012; Silsupadol 2006; Yamada 2011). There is a published review about dual task training for people with stroke, which focuses on dual task training with cognitive secondary tasks (Wang 2015). This review came to the conclusion that cognitive motor interference is effective for improving balance and gait in the short term. However, the authors did not include both types of secondary tasks, that is cognitive and manual tasks, and they did not evaluate their long-term outcomes (Wang 2015).

Description of the intervention

Everyday life involves many dual task situations, in which a person needs to do two or more things simultaneously: walking while talking to someone, walking through the supermarket and looking for a certain product, carrying a tray with food while walking. Without the ability to carry out these types of simultaneous movements the ability to cope with everyday life is severely impaired. Additionally, it is assumed that the lack of ability to carry out dual tasks is one reason why people stumble and fall. Dual task training aims to improve the ability to do two or more things simultaneously and thus reduce the risk of falling. One can differentiate between 1. dual task training with a cognitive dual task, and 2. dual task training with a manual dual task. Dual task training consists of a primary task and an additional secondary task. The two tasks could be performed independently as a single task and have distinct and separate goals. In a dual task intervention, people practice both tasks simultaneously. The primary task of interest in this review is an exercise intervention that aims to improve gait or balance. Examples of gait tasks are walking with usual or reduced base of support, walking backwards, walking sideways and walking under dim light conditions (Silsupadol 2006). Examples of body stability tasks are standing quietly with usual or reduced base of support, standing with eyes closed, tandem standing, recovery of standing following manual perturbations and standing on compliant or moving surfaces (Silsupadol 2006). The secondary task could involve a manual task (e.g. walking and carrying a glass of water, walking and carrying a tray with glasses, coin transfer, buttoning, walking and bouncing a ball, catching or throwing a ball while walking). Another possibility of a secondary task is a cognitive task (e.g. word list generation, colour classification, counting backwards, counting backwards by threes, verbal response, memorising a list of words, answering questions, digit retention, repeating days of week backwards, reciting male names or alternating letters).

Dual task interventions are usually provided individually by physiotherapists, physical therapists or sports therapists. Group therapy is possible, but the supervision of the people in a group may be difficult. Under dual task conditions the risk of falling or losing balance is high, so the therapists must be able to protect, catch, or save the person during the whole intervention. Dual task training can be provided in different settings: hospital, inpatient rehabilitation, outpatient practice, nursing home or at the person's homes. Exercise therapies usually take place one to five times a week for two to six weeks (Wang 2015). An exercise session normally takes 20 to 45 minutes (Shin 2014; Silsupadol 2006).

How the intervention might work

A first simple definition of balance or postural control refers to the ability to control one's own position of the centre of mass and the area of the base of support. Pollock and colleagues defined postural control as "the act of maintaining, achieving or restoring a state of balance during any posture or activity" (Pollock 2000; page 402). The improvement of balance and walking ability is an essential aim in the therapy of stroke to preserve ADL. Simultaneous training of motor or cognitive dual tasks during conventional therapy has already been considered as beneficial for different groups of people (Pichierri 2012; Plummer 2014; Silsupadol 2006; Yamada 2011).

In more recent research, the inability to perform two or more tasks simultaneously (multi- or dual tasking) is regarded as an indicator for a higher fall risk (Beauchet 2009; Faulkner 2007; Montero-Odasso 2012; Quinn 2013). These observations are based on research results showing that the cognitive capacity for processing information is limited (Hall 2011; Mirelman 2012; Pashler 1994).

One common theory that explains the limited cognitive capacity is the attentional capacity theory (Kahnemann 1973; Paul 2005; Wickens 2008; Woollacott 2002). This theory states that the attentional capacity of a person is limited. Given tasks require a certain amount of attentional capacity. If the maximum capacity is reached when dual tasks are being performed, performance on one or both of the tasks will decline.

In addition, the bottleneck theory describes that there is a point in information processing where only one task can be performed at a time. As a consequence, the individual performance will also decline under dual task conditions (Pashler 1994).

There is a third theoretical explanation discussed in which self-awareness of limitations and environmental demands causes a prioritisation of one task over the other by individuals. Actual research has shown that different patient groups use different prioritisation strategies: for example, older people prefer a posture first strategy (Cordo 1982; Shumway-Cook 1997), while, conversely, people with Parkinson's disease prefer a posture second strategy (Yogev-Seligmann 2012).

There are three hypotheses of how dual task training might work. First, people learn to integrate two tasks more efficiently (Ruthruff 2006). Second, dual task training can improve the automatisation (Clark 2015) of the primary task (Bahrick 1954; Ruthruff 2006), that is, the primary task will need less cognitive capacity. Consequently, more cognitive capacity can be used for additional tasks. Finally, dual task training results in faster information processing (Ruthruff 2006). In one experimental study, Ruthruff and coworkers found evidence that automatisation and a shorter duration of the 'bottleneck' are the main effects of dual tasking training (Ruthruff 2006).

Plummer and coworkers analysed the state of science regarding cognitive-motor interferences during functional mobility after stroke (Plummer 2013). They found typical patterns of cognitive-motor interferences for people with stroke. In dual task settings with gait as the primary task and a cognitive task as the secondary task, the gait performance worsened and the cognitive performance was stable (cognitive-related motor interference). The second typical pattern was that both gait performance and cognitive performance worsened (mutual interference) in a dual task situation. Plummer and colleagues also found typical patterns for balance and postural control in dual task situations (Plummer 2013). The patterns depend on the measured outcome. Typical patterns were 1. improved motor performance and stable cognitive performance, 2. worsened motor performance and worsened cognitive performance (both for measures of postural sway), and 3. worsened motor performance and stable cognitive performance (for centre of pressure and weight-bearing asymmetry). Plummer and coworkers also found some studies that described the result that most people with stroke have a mutual interference or cognitive-related motor interference in gait-related dual task conditions after discharge from rehabilitation. They stated: "In summary, it appears that conventional rehabilitation does not significantly reduce CMI [cognitive-motor interference] after stroke" (Plummer 2013; page 8).

Amboni and coworkers summarised the cognitive contribution to gait and falls and stated that there is an interaction between cognitive impairment and gait abnormalities (Amboni 2013). In conclusion, they suggest that cognitive training could prevent falls and improve mobility - whereas gait training could improve cognitive skills (Montero-Odasso 2012). This supports the thesis that dual task training might work regarding mobility and fall prevention.

Why it is important to do this review

In recent years, dual task training has developed into an emerging approach for gait and balance training in people experiencing neurological conditions such as stroke (Amboni 2013; Fritz 2015; Plummer 2013). The combination of common gait and balance training with a dual task has been hypothesised to be beneficial for improving balance and walking impairments in people with stroke (Plummer 2014). Hence, dual task training could enhance ambulation, a precondition of many ADLs, and reduce risks such as falling. Therefore, a Cochrane Review would be useful to compile all available high-level evidence and to assess the treatment effects of dual task training for people with stroke and resulting balance and walking impairments.

OBJECTIVES

To assess the treatment effects of dual task training regarding balance and gait for people with stroke.

METHODS

Criteria for considering studies for this review

Types of studies

We will include all randomised controlled trials (RCTs), quasi-randomised controlled trials and cross-over studies. For cross-over

studies, we will only include the data from the first period of the study.

Types of participants

We will include people above the age of 18 years, regardless of sex, setting and duration of illness who have been clinically diagnosed with stroke. We will include RCTs with mixed populations (people with stroke and people with other conditions) that meet our inclusion criteria when the data for people with stroke are available separately.

Types of interventions

We will include any type of exercise therapy with a dual task that aims to improve gait or balance as described in the Description of the intervention section. We will include both types of secondary tasks (i.e. manual and cognitive tasks).

Control groups of interest include any type of exercise therapy without dual tasking, therapy as usual, minimal intervention, no treatment or placebo treatment. We will assign and analyse study data regarding its comparator (active or passive) to the following two comparisons:

- dual task training versus other active exercise training (active comparator);
- dual task training versus no treatment or placebo treatment (passive comparator).

Types of outcome measures

The primary outcome chosen - ADL - and the secondary outcome - health-related quality of life (HRQoL) - are patient-relevant outcomes. For people with stroke it is of major importance that, as a result of the therapies, they see improvements in the way they cope in everyday life, which in turn will have a positive effect on their QoL. Although a therapy can also demonstrate measurable improvements of body functions, there is always a question, if these improvements are relevant, when they have no positive effect on the everyday life of the person. Nevertheless, we will not exclude outcomes on the level of body functions and structures from our review; we will include them as secondary outcomes. These secondary outcomes are gait and balance. In this way, we will consider all dimensions of the International Classification of Functioning, Disability and Health (WHO 2005). Furthermore, we decided on death, the number of falls, and adverse events as additional secondary outcomes, as these are also patient-relevant outcomes.

We will define the timing of outcome measures of interest as follows: 1. outcome measures directly after the end of the intervention, 2. after a short follow-up (up to three months), and 3. after a longer follow-up (over three months).

Primary outcomes

- Activities of daily living (ADL). Suitable assessments for ADL are, for example, the Functional Independence Measure (FIM) (Granger 1993), the Barthel Index (Lachs 1990), the Participation Measure for Post-acute Care (PAM-PAC) (Gandek 2007), and the Frenchay Activities Index (FAI) (Holbrook 1983).

Secondary outcomes

- Health-related quality of life (HRQoL): appropriate outcome measures are scales such as the Stroke Specific Quality of Life Scale (SS-QOL) (Williams 1999), the Stroke Impact Scale (Duncan 1999), and the 36-item Short Form Health Survey Questionnaire (SF-36) (Anderson 1996).
- Balance: appropriate outcome measures (Pollock 2011) are scales such as the Brunel Balance Assessment (Tyson 2004), the Modified Emory Functional Ambulation Profile (Wolf 1979, Baer 2001), the Dynamic Gait Index (Shumway-Cook 1995), the Berg Balance Scale (Berg 1992), the Community Balance and Mobility Scale (Knorr 2010), the Mini-Balance Evaluation Systems Test (Tsang 2013), and the Activities-Specific Balance Confidence Scale (Botner 2005). In addition, there are single task tests such as the Step Test, the Side Step Test, and the Four and Square Step Test.
- Gait: possible outcome measures will be walking velocity (measured by timed measures of gait on a short distance of 5 to 10 m), step/stride length, cadence and the Timed Up and Go Test (Podsiadlo 1991). These assessments measure different domains and we will not combine them. We will discuss including any other outcome measure for assessing gait that is reported in the included studies.
- Falls.
- Adverse events.
- Drop outs (including death from all causes).

Search methods for identification of studies

See the 'Specialized register' section in the Cochrane Stroke Group module. We will search for trials in all languages and arrange for the translation of relevant articles where necessary.

Electronic searches

We will search the Cochrane Stroke Group trials register and the following electronic databases:

- the Cochrane Central Register of Controlled Trials (CENTRAL) (The Cochrane Library, latest issue) (Appendix 1);
- MEDLINE (from 1948; Appendix 2);
- Embase (from 1980; Appendix 3);
- CINAHL via EBSCOhost (Appendix 4);
- AMED via OvidSP (Appendix 5);
- Web of Science (Appendix 6);
- PEDro (Appendix 7);
- REHABData (Appendix 8);
- Clinical trials registries (clinicaltrials.gov) and the WHO International Clinical Trials Registry Platform (ICTRP) search portal (apps.who.int/trialsearch/Default.aspx) for all prospectively registered and ongoing trials (Appendix 9).

We will also search the following ongoing trials registers:

- Stroke Trials Registry (www.strokecenter.org/trials/);
- Current Controlled Trials (www.controlled-trials.com).

Searching other resources

In addition, we will search the bibliographies of articles included in the review as well as reviews and guidelines for other studies that match our inclusion criteria.

Data collection and analysis

Selection of studies

Two review authors (MH, MM) will independently screen all abstracts and titles of studies identified by the search strategy and exclude all studies that are obviously irrelevant or do not match the inclusion criteria. The same two review authors will independently evaluate the remaining studies using the full text to identify appropriate studies for inclusion. If these two review authors cannot reach a consensus about the eligibility of a study, all review authors will discuss the study for a final consensus decision. If necessary, we will contact the authors of a study to request further information that may help to clarify the eligibility.

Data extraction and management

Two review authors (MH, MM) will independently extract data from the studies and collect the data in a standardised data collection form. If there is a lack of data or something is unclear, we will contact the study authors to request detailed information. Where there is disagreement regarding data collection, a third review author will check the data. All data will be collected as described in Section 7.3 of the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011).

Source

- Study ID (created by review author).
- Report ID (created by review author).
- Review author ID (created by review author).
- Citation and contact details.

Eligibility

- Confirm eligibility for review.
- Reason for exclusion.

Methods

- Study design.
- Total study duration.
- Sequence generation.
- Allocation sequence concealment.
- Blinding of participants and personnel
- Blinding of outcome assessors.
- Other concerns about bias.

Participants

- Total number.
- Setting.
- Diagnostic criteria.
- Age.
- Sex.
- Country.
- Comorbidity.
- Date of study.
- Type and duration of stroke.

Interventions

- Total number of intervention group.

For each intervention and comparison group of interest

- Specific intervention.
- Intervention details:
  - primary task;
  - secondary task;
  - personnel providing the intervention;
  - mode (standardised or participant-tailored) and setting (in-patient/outpatient/home, etc.) of intervention;
  - dosage (duration, frequency and number of sessions).
- Integrity of intervention.

Outcomes

- Outcomes and time points collected and reported.

For each outcome of interest

- Outcome definition (with diagnostic criteria if relevant).
- Unit of measurement (if relevant).
- For scales: upper and lower limits, and whether high or low score is better.

Results

- Number of participants allocated to each intervention group.

For each outcome of interest

- Sample size.
- Missing participants.
- Summary data for each intervention.
- Estimate of effect with confidence interval (CI); P value.
- Subgroup analyses.

Miscellaneous

- Funding source.
- Key conclusions of the study authors.
- Miscellaneous comments from the study authors.
- References to other relevant studies.
- Correspondence required.
- Miscellaneous comments by the review authors.

Assessment of risk of bias in included studies

Two review authors (MH, MM) will independently assess the risk of bias for each study using the criteria outlined in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011). We will resolve any disagreement through discussion or by involving another review author (BE). We will assess the risk of bias according to the following domains.

- Random sequence generation.
- Allocation concealment.
- Blinding of participants and personnel.
- Blinding of outcome assessment.
- Incomplete outcome data.
- Selective outcome reporting.
- Other bias.

We will grade the risk of bias for each domain as high, low or unclear and provide information about the biases from the study re-

port together with a justification for our judgement in the 'Risk of bias' tables.

Measures of treatment effect

We will enter and analyse the data in Review Manager 5 (RevMan 2014). For any measures of treatment effects of continuous outcomes, we will calculate mean differences (MDs) and their corresponding 95% CI. If the same outcome was measured with different outcome measurements, we will calculate standardised mean differences (SMD) instead of MDs. For any binary outcomes, we will calculate risk ratios (RR).

We expect that the interventions will differ regarding their exercises, duration, intensity and type of dual task. Therefore, we will use a random-effects model.

Unit of analysis issues

If we identify cluster-randomised studies or any non-parallel designs, we will consider their inclusion, following guidance in Chapter 16 of the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011).

Dealing with missing data

We will contact the authors of the respective studies to ask for missing information. If we are unable to obtain the missing data from the authors or if a study does not report outcome data that can be used in our analysis, we will include the study only in a qualitative synthesis.

Assessment of heterogeneity

We will use the I^2 statistic to assess heterogeneity as described in Chapter 9.5.2 of the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011).

We will categorise the heterogeneity as:

- I^2 = 0% to 24%, low heterogeneity;
- I^2 = 25% to 49%, moderate heterogeneity;
- I^2 = 50% to 74%, substantial heterogeneity;
- I^2 = 75% to 100%, considerable heterogeneity.

Regardless of the level of heterogeneity, we will use a random-effects model (see Measures of treatment effect). We will explore the reasons for heterogeneity and identify whether there are clinical or methodological explanations for differences in treatment effects between studies. We will also explore the effect of removing visual outliers. The sensitivity analyses and the subgroup analyses may provide further insight into potential sources of heterogeneity. If there is considerable heterogeneity that cannot be explained, we will downgrade the quality of evidence (Guyatt 2011).

Assessment of reporting biases

We will examine the presence of reporting bias by visual inspection of funnel plots using all studies that meet the entry criteria, if appropriate (Higgins 2011).

Data synthesis

Two review authors (MM, MH) will independently extract data from the studies included. We will perform all analyses using Review Manager 5 (RevMan 2014). One review author (MM) will enter the data into Review Manager 5. Two review authors (MH, BE) will check the entered data.

GRADE and 'Summary of findings' table

We will create a 'Summary of findings' table to compare dual task training versus no treatment or placebo treatment and dual task training versus other active exercise training using the following outcomes: ADL, HRQoL, balance, gait, falls, adverse events and dropouts.

We will use the five GRADE considerations (study limitations, consistency of effect, imprecision, indirectness and publication bias) to assess the quality of a body of evidence as it relates to the studies which contribute data to the meta-analyses for the prespecified outcomes. We will use the methods and recommendations described in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011), and will use the GRADEpro software (GRADEpro GDT). We will justify all decisions to downgrade or upgrade the quality of studies by using footnotes and comments to aid understanding of the review where necessary.

Subgroup analysis and investigation of heterogeneity

We will perform a subgroup analysis for the different types of secondary tasks (i.e. cognitive and manual) and for the type of base treatment (active or passive comparator).

In addition, we plan to do a subgroup analysis for the different durations of stroke: acute (up to four weeks after stroke onset), post-acute (one month to six months after stroke onset) and chronic (from the sixth month after stroke onset) (van Peppen 2014).

We will perform a subgroup analysis for primary outcomes only.

Sensitivity analysis

We will carry out a sensitivity analysis for risk of bias of the studies included to assess the robustness of our results. We will analyse according to random sequence generation, allocation concealment and blinding of outcome assessors. We will remove all studies with a high or unclear risk of bias in one or more of these three domains.

ACKNOWLEDGEMENTS

None.

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APPENDICES

Appendix 1. CENTRAL search strategy

#1 [mh ^"cerebrovascular disorders"] or [mh "basal ganglia cerebrovascular disease"] or [mh "brain ischemia"] or [mh "carotid artery diseases"] or [mh "intracranial arterial diseases"] or [mh "intracranial embolism and thrombosis"] or [mh "intracranial hemorrhages"] or [mh ^stroke] or [mh "brain infarction"] or [mh ^"vertebral artery dissection"]

#2 (stroke or poststroke or "post-stroke" or cerebrovasc* or brain next vasc* or cerebral next vasc* or cva* or apoplex* or SAH):ti,ab

#3 ((brain* or cerebr* or cerebell* or intracran* or intracerebral) near/5 (isch*emi* or infarct* or thrombo* or emboli* or occlus*)):ti,ab

#4 ((brain* or cerebr* or cerebell* or intracerebral or intracranial or subarachnoid) near/5 (haemorrhage* or hemorrhage* or haematoma* or hematoma* or bleed*)):ti,ab

#5 [mh ^hemiplegia] or [mh paresis]

#6 (hemipleg* or hemipar* or paresis or paretic or hemineglect or "hemi-neglect" or ((unilateral or spatial or hemi*spatial or visual) near/5 neglect)):ti,ab

#7 #1 or #2 or #3 or #4 or #5 or #6

#8 [mh ^"psychomotor performance"]

9 (dual OR second*) near/5 task*

10 cognitive near/5 motor near/5 interference

#11 #8 or #9 or #10

#12 #7 and #11

Appendix 2. MEDLINE (OvidSP) search strategy

1. cerebrovascular disorders/ or exp basal ganglia cerebrovascular disease/ or exp brain ischemia/ or exp carotid artery diseases/ or exp intracranial arterial diseases/ or exp "intracranial embolism and thrombosis"/ or exp intracranial hemorrhages/ or stroke/ or exp brain infarction/ or vertebral artery dissection/

2. (stroke or poststroke or post-stroke or cerebrovasc$ or brain vasc$ or cerebral vasc$ or cva$ or apoplex$ or SAH).tw.

3. ((brain$ or cerebr$ or cerebell$ or intracran$ or intracerebral) adj5 (isch?emi$ or infarct$ or thrombo$ or emboli$ or occlus$)).tw.

4. ((brain$ or cerebr$ or cerebell$ or intracerebral or intracranial or subarachnoid) adj5 (haemorrhage$ or hemorrhage$ or haematoma $ or hematoma$ or bleed$)).tw.

5. hemiplegia/ or exp paresis/

6. (hemipleg$ or hemipar$ or paresis or paretic or hemineglect or hemi-neglect or ((unilateral or spatial or hemi?spatial or visual) adj5 neglect)).tw.

7. or/1-6

8. exp Psychomotor Performance/ or exp Attention/

9. ((dual or second$) adj5 task$).tw.

10. cognitive near/5 motor near/5 interference

11. or/8-10

12. Randomized Controlled Trials as Topic/

13. random allocation/

14. Controlled Clinical Trials as Topic/

15. control groups/

16. clinical trials as topic/ or clinical trials, phase i as topic/ or clinical trials, phase ii as topic/ or clinical trials, phase iii as topic/ or clinical trials, phase iv as topic/

17. double-blind method/

18. single-blind method/

19. Placebos/

20. placebo effect/

21. cross-over studies/

22. randomized controlled trial.pt.

23. controlled clinical trial.pt.

24. (clinical trial or clinical trial phase i or clinical trial phase ii or clinical trial phase iii or clinical trial phase iv).pt.

25. (random$ or RCT or RCTs).tw.

26. (controlled adj5 (trial$ or stud$)).tw.

27. (clinical$ adj5 trial$).tw.

28. (quasi-random$ or quasi random$ or pseudo-random$ or pseudo random$).tw.

29. ((control or experiment$ or conservative) adj5 (treatment or therapy or procedure or manage$)).tw.

30. ((singl$ or doubl$ or tripl$ or trebl$) adj5 (blind$ or mask$)).tw.

31. (cross-over or cross over or crossover).tw.

32. (placebo$ or sham).tw.

33. trial.ti.

34. (assign$ or allocat$).tw.

35. controls.tw.

36. or/12-36

37. 7 and 11 and 36

38. exp animals/ not humans.sh.

39. 37 not 38

Appendix 3. EMBASE (OvidSP) search strategy

1. cerebrovascular disease/ or exp basal ganglion hemorrhage/ or exp brain hematoma/ or exp brain hemorrhage/ or exp brain infarction/ or exp brain ischemia/ or exp carotid artery disease/ or cerebral artery disease/ or exp cerebrovascular accident/ or exp intracranial aneurysm/ or exp occlusive cerebrovascular disease/ or stroke patient/

2. (stroke or poststroke or post-stroke or cerebrovasc$ or brain vasc$ or cerebral vasc$ or cva$ or apoplex$ or SAH).tw.

3. ((brain$ or cerebr$ or cerebell$ or intracran$ or intracerebral) adj5 (isch?emi$ or infarct$ or thrombo$ or emboli$ or occlus$)).tw.

4. ((brain$ or cerebr$ or cerebell$ or intracerebral or intracranial or subarachnoid) adj5 (haemorrhage$ or hemorrhage$ or haematoma $ or hematoma$ or bleed$)).tw.

5. hemiparesis/ or hemiplegia/ or paresis/

6. (hemipleg$ or hemipar$ or paresis or paretic or hemineglect or hemi-neglect or ((unilateral or spatial or hemi?spatial or visual) adj5 neglect)).tw.

7. or/1-6

8. exp psychomotor performance/ or exp task performance/ or exp "dual-task performance (test)"/

9. ((dual or second$) adj5 task$).tw.

10. (cognitive adj5 motor adj5 interference).tw

11. or/8-10

12. Randomized Controlled Trial/ or "randomized controlled trial (topic)"/

13. Randomization/

14. Controlled clinical trial/ or "controlled clinical trial (topic)"/

15. control group/ or controlled study/

16. clinical trial/ or "clinical trial (topic)"/ or phase 1 clinical trial/ or phase 2 clinical trial/ or phase 3 clinical trial/ or phase 4 clinical trial/

17. Crossover Procedure/

18. Double Blind Procedure/

19. Single Blind Procedure/ or triple blind procedure/

20. placebo/ or placebo effect/

21. (random$ or RCT or RCTs).tw.

22. (controlled adj5 (trial$ or stud$)).tw.

23. (clinical$ adj5 trial$).tw.

24. ((control or treatment or experiment$ or intervention) adj5 (group$ or subject$ or patient$)).tw.

25. (quasi-random$ or quasi random$ or pseudo-random$ or pseudo random$).tw.

26. ((control or experiment$ or conservative) adj5 (treatment or therapy or procedure or manage$)).tw.

27. ((singl$ or doubl$ or tripl$ or trebl$) adj5 (blind$ or mask$)).tw.

28. (cross-over or cross over or crossover).tw.

29. (placebo$ or sham).tw.

30. trial.ti.

31. (assign$ or allocat$).tw.

32. controls.tw.

33. or/12-32

34. 7 and 11 and 33

35. (exp animals/ or exp invertebrate/ or animal experiment/ or animal model/ or animal tissue/ or animal cell/ or nonhuman/) not (human/ or normal human/ or human cell/)

36. 34 not 35

Appendix 4. CINAHL search strategy (EBSCO)

S1 .(MH "Cerebrovascular Disorders") OR (MH "Basal Ganglia Cerebrovascular Disease+") OR (MH "Carotid Artery Diseases+") OR (MH "Cerebral Ischemia+") OR (MH "Cerebral Vasospasm") OR (MH "Intracranial Arterial Diseases+") OR (MH "Intracranial Embolism and Thrombosis") OR (MH "Intracranial Hemorrhage+") OR (MH "Stroke") OR (MH "Vertebral Artery Dissections")

S2 .(MH "Stroke Patients") OR (MH "Stroke Units")

S3 .TI (stroke or poststroke or post-stroke or cerebrovasc* or brain vasc* or cerebral vasc or cva or apoplex or SAH) or AB (stroke or poststroke or post-stroke or cerebrovasc* or brain vasc* or cerebral vasc or cva or apoplex or SAH)

S4 .TI (brain* or cerebr* or cerebell* or intracran* or intracerebral) or AB (brain* or cerebr* or cerebell* or intracran* or intracerebral)

S5 .TI (ischemi* or ischaemi* or infarct* or thrombo* or emboli* or occlus*) or AB (ischemi* or ischaemi* or infarct* or thrombo* or emboli* or occlus*)

S6 .S4 and S5

S7 .TI (brain* or cerebr* or cerebell* or intracerebral or intracranial or subarachnoid) or AB (brain* or cerebr* or cerebell* or intracerebral or intracranial or subarachnoid)

S8 .TI (haemorrhage* or hemorrhage* or haematoma* or hematoma* or bleed*) or AB (haemorrhage* or hemorrhage* or haematoma* or hematoma* or bleed*)

S9 .S7 and S8

S10 .(MH "Hemiplegia")

S11 .TI (hemipleg* or hemipar* or paresis or paretic) or AB (hemipleg* or hemipar* or paresis or paretic)

S12 .(MH "Unilateral Neglect") OR (MH "Unilateral Neglect (Saba CCC)") OR (MH "Unilateral Neglect (NANDA)")

S13 .TI ((unilateral or spatial or hemispatial or hemi-spatial or visual) N5 neglect) or AB ((unilateral or spatial or hemispatial or hemi-spatial or visual) N5 neglect)

S14 .S1 OR S2 OR S3 OR S6 OR S9 OR S10 OR S11 OR S12 OR S13

S15 .(MW "Dual-task training" OR MM "Task Performance and Analysis")

S16 .TI ((dual or second*) N5 task*)

S17 .TI (cognitive N5 motor N5 interference)

S18 . S15 OR S16 OR S17

S19 .(MH "Randomized Controlled Trials") or (MH "Random Assignment") or (MH "Random Sample+")

S20 .(MH "Clinical Trials") or (MH "Intervention Trials") or (MH "Therapeutic Trials")

S21 .(MH "Double-Blind Studies") or (MH "Single-Blind Studies") or (MH "Triple-Blind Studies")

S22 .(MH "Control (Research)") or (MH "Control Group") or (MH "Placebos") or (MH "Placebo Effect")

S23 .(MH "Crossover Design") OR (MH "Quasi-Experimental Studies")

S24 .PT (clinical trial or randomized controlled trial)

S25 .TI (random* or RCT or RCTs) or AB (random* or RCT or RCTs)

S26 .TI (controlled N5 (trial* or stud*)) or AB (controlled N5 (trial* or stud*))

S27 .TI (clinical* N5 trial*) or AB (clinical* N5 trial*)

S28 .TI ((control or treatment or experiment* or intervention) N5 (group* or subject* or patient*)) or AB ((control or treatment or experiment* or intervention) N5 (group* or subject* or patient*))

S29 .TI ((control or experiment* or conservative) N5 (treatment or therapy or procedure or manage*)) or AB ((control or experiment* or conservative) N5 (treatment or therapy or procedure or manage*))

S30 .TI ((singl* or doubl* or tripl* or trebl*) N5 (blind* or mask*)) or AB ((singl* or doubl* or tripl* or trebl*) N5 (blind* or mask*))

S31 .TI (cross-over or cross over or crossover) or AB (cross-over or cross over or crossover)

S32 .TI (placebo* or sham) or AB (placebo* or sham)

S33 .TI trial

S34 .TI (assign* or allocat*) or AB (assign* or allocat*)

S35 .TI controls or AB controls

S36 .TI (quasi-random* or quasi random* or pseudo-random* or pseudo random*) or AB (quasi-random* or quasi random* or pseudo-random* or pseudo random*)

S37 .S19 OR S20 OR S21 OR S22 OR S23 OR S24 OR S25 OR S26 OR S27 OR S28 OR S29 OR S30 OR S31 OR S32 OR S33 OR S34 OR S35 OR S36

S37 .S14 AND S18 AND S37

Appendix 5. AMED (OvidSP) search strategy

1. cerebrovascular disorders/ or cerebral hemorrhage/ or cerebral infarction/ or cerebral ischemia/ or cerebrovascular accident/ or stroke/

2. (stroke or poststroke or post-stroke or cerebrovasc$ or brain vasc$ or cerebral vasc$ or cva$ or apoplex$ or SAH).tw.

3. ((brain$ or cerebr$ or cerebell$ or intracran$ or intracerebral) adj5 (isch?emi$ or infarct$ or thrombo$ or emboli$ or occlus$)).tw.

4. ((brain$ or cerebr$ or cerebell$ or intracerebral or intracranial or subarachnoid) adj5 (haemorrhage$ or hemorrhage$ or haematoma $ or hematoma$ or bleed$)).tw.

5. hemiplegia/

6. (hemipleg$ or hemipar$ or paresis or paretic or hemineglect or hemi-neglect or ((unilateral or spatial or hemi?spatial or visual) adj5 neglect)).tw.

7. or/1-6

8. Balance/ or Attention/ or Walking/ or exp Psychomotor disorders/

9. ((dual or second$) adj5 task$).tw.

10. (cognitive adj5 motor adj5 interference)

11. or/8-10

12. 7 and 11

Appendix 6. Web of Science search strategy

#1.TS=(stroke or poststroke or post-stroke or cerebrovasc* or brain vasc* or cerebral vasc* or cva* or apoplex* or SAH)

#2.TS=((brain* or cerebr* or cerebell* or intracran* or intracerebral) NEAR/5 (isch$emi* or infarct* or thrombo* or emboli* or occlus*))

#3.TS=((brain* or cerebr* or cerebell* or intracerebral or intracranial or subarachnoid) NEAR/5 (haemorrhage* or hemorrhage* or haematoma* or hematoma* or bleed*))

#4.TS=(hemipleg* or hemipar* or paresis or paretic or hemineglect or hemi-neglect)

#5.TS=((unilateral or spatial or hemi$spatial or visual) NEAR/5 neglect)

#6.#5 OR #4 OR #3 OR #2 OR #1

#7.TS=((dual or second*) NEAR/5 task*)

#8.TS=(cognitive NEAR/5 motor NEAR/5 interference)

#9.#7 OR #8

#10.#7 AND #9

Appendix 7. PEDro search strategy

Abstract & Title: stroke dual task
Method: clinical trial
(Search terms matched with AND)

Appendix 8. REHABDATA search strategy

Find results with all of the words: stroke
Where Abstract OR Title contains dual task

Appendix 9. Clinicaltrials.gov search strategy

Search terms: stroke dual task

WHAT'S NEW

Date	Event	Description
27 September 2019	Amended	'Declarations of interest' section clarified

CONTRIBUTIONS OF AUTHORS

MH and MM wrote the protocol.

BE supervised and supported the process of writing the protocol.

All authors read and approved the protocol prior to publication.

DECLARATIONS OF INTEREST

MH and MM: NTZ Dresden is an outpatient clinic specialising in the treatment of people with neuromuscular and neurological disorders. IFEP Dresden is a private research institution, aiming at closing the evidence-practice gap. Neither institution has any financial or other interest in the dual task training approach.

BE: none known.

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